



Jones, M., Parry, M., Whitehouse, M., & Blom, A. (2017). Early death following revision total hip arthroplasty. *Hip International*.
<https://doi.org/10.5301/hipint.5000593>

Peer reviewed version

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EARLY DEATH FOLLOWING REVISION TOTAL HIP ARTHROPLASTY

Short Title: Early Death Following Revision Total Hip Arthroplasty

Mark D Jones BSc MRCS ^{*1,2}, Michael Parry BSc MD FRCS ^{1,3}, Michael Whitehouse
BSc MSc PhD FRCS ¹, Ashley W Blom MD PhD FRCS ¹

¹Musculoskeletal Research Unit, Level 1 Learning and Research Building,
Southmead Hospital, Westbury on Trym, Bristol, BS10 5NB

²William Harvey Hospital, East Kent Hospitals University NHS Foundation Trust,
Kennington Road, Willesborough, Ashford, Kent, TN24 0LZ

³The Royal Orthopaedic Hospital, Bristol Road South, Northfield, Birmingham, B31
2AP

*Address for Correspondence:

Mark Jones

Trauma and Orthopaedic Department

²William Harvey Hospital, East Kent Hospitals University NHS Foundation Trust,
Kennington Road, Willesborough, Ashford, Kent, TN24 0LZ

markdjones1984@gmail.com

[07792056190](tel:07792056190)

Manuscript Word Count: 2793

Abstract

Introduction: The frequency of primary total hip arthroplasty procedures is increasing, with a subsequent rise in revision procedures. This study aims to describe timing and surgical mortality associated with revision total hip arthroplasty compared to those on the waiting list.

Methods: All patients from a single institution who underwent revision total hip arthroplasty or added to the waiting list for the same procedure between 2003 and 2013 were recorded. Mortality rates were calculated at 30- and 90-days following surgery or addition to the waiting list

Results: 561 patients were available for the survivorship analysis in the surgical group. Following exclusion, 901 and 484 patients were available for the 30- and the 90-day analysis in the revision total hip arthroplasty waiting list group.

30- and 90-day mortality rates were significantly greater for the revision total hip arthroplasty group compared to the waiting list group (excess surgical mortality at 30-days=0.357%, $p=0.037$; odds ratio of 5.22, excess surgical mortality at 90-days=0.863%, $p=0.045$).

Conclusion: Revision total hip arthroplasty is associated with a significant excess surgical mortality rate until 90-days post-operation when compared to the waiting list population. We would encourage other authors with access to larger samples to use our method to quantify excess mortality after both primary and revision arthroplasty procedures.

Keywords: Arthroplasty, Hip Replacement, Mortality, Reoperation, Surgical

Introduction

Total hip arthroplasty (THA) is a widely accepted treatment for debilitating arthritis of the hip, offering high levels of cost effectiveness and patient satisfaction [1-3]. The number of primary arthroplasty procedures is increasing [4-7], with a consequent increase in the demand for revision THA procedures [4,5,8-10]. In England and Wales, the number of primary THAs rose from 70,395 in 2010 to 83,886 in 2015, an increase of over 19% [4]. The revision THA burden is projected to increase significantly over the next 15 years [11]. In England and Wales, the number of revision THAs rose from 8,186 in 2010 to 8,367 in 2015, it is worth note that there is a greater time lag for recording revision procedures in the NJR and the peak number of revisions is seen in 2012 with 10,497 performed [4]. Assuming that the pattern in revisions represents this data lag, there has been between a 2 and 28% increase.

The most common indications for revision in THA are aseptic loosening (30%), pain (13.5%), lysis (9.5%), dislocation/subluxation (8.9%), wear (8.3%), infection (8.2%) and periprosthetic fracture (5.8%) [4]. Whilst it remains a rare complication of revision THA, mortality has been reported to be between 0.9% and 2.6% at 90-days post operation [4, 12-14], with an increased incidence in those over 80 years of age [13,15].

When counselling patients undergoing revision THA, it is important to provide accurate information regarding potential complications. However, the excess mortality associated with this procedure remains ill-defined. Death rates for primary arthroplasty are often compared to age and sex matched populations, or standardised mortality ratios amongst the general population. This approach has

demonstrated an apparent protective effect of arthroplasty surgery and improved survival for those undergoing primary THA [16-19]. In order to account for this “well patient” phenomenon, we have previously compared 30- and 90-day mortality in patients undergoing either primary THA [20] or primary TKA [21] with those awaiting the same procedure, and demonstrated that mortality is significantly increased at 30-days for both primary THA and TKA and significantly increased at 90-days for primary TKA. The rationale with using patients on the waiting list as the baseline is that they are patients with osteoarthritis who are well enough to undergo surgery and thus constitute a valid comparator group, whilst the general population are sicker and thus have higher standardised mortality rates than those undergoing joint replacement, who have been selected by their fitness for surgery.

The aim of this study was to use this established methodology to investigate the timing and cause of mortality following revision THA. A recent study has shown that the majority of excess mortality occurs in the first 30 post-operative days and that mortality rates decline to baseline by 90-days for primary THA [22]. We therefore aimed to identify the mortality rate at both 30- and 90-days following revision THA, and to compare it to a population of patients on the waiting list for the same procedure.

Methods

All patients undergoing revision THA (n=600) in a regional elective orthopaedic unit formed the revision arthroplasty population for the study (Figure 1). Procedures were completed between April 2003 and August 2013, allowing sufficient time for death to be recorded. Details regarding patient age, sex and date of death where applicable,

were recorded. Patients who underwent multiple revision THA (n=39, 6.5%) procedures had their first procedure included and the subsequent procedures excluded.

A second data set was prepared comprising all patients added to the same unit's waiting list for the same procedure (n=1,309) (Figure 2). Again, patient demographics were recorded, as were date of removal from the waiting list as well as reason for removal if recorded. Exclusion criteria included those patients who could not be traced via the Demographics Batch Service through the National Health Service (NHS) and Personal Demographics Service (n=4, 0.306%), duplicate entries without an admission for a procedure (n=8, 0.0611%), inadequate data for analysis (n=3, 0.229%) and if they were removed from the waiting list without being admitted for an elective procedure (n=205, 15.7%). Due to the nature of the retrospective study, detailed reasons for removal could not be analysed. However, possible causes are as described. All patients were seen prior to their operation in a pre-assessment clinic. At this time, an assessment of comorbidity was performed at which stage medical reasons for exclusion from surgery were identified. These included poorly controlled hypertension, diabetes, ischemic heart disease, respiratory illness and renal dysfunction. Patients for whom surgery was deemed to carry excessive risk were removed from the waiting list and therefore, not included in either the waiting list group or the surgical group in this study. Patients who were on the waiting list but were admitted for an emergency procedure would have been removed from the elective waiting list and would therefore have been excluded from this study. Of those remaining (1,089 patients on the waiting list for revision THA), patients who were on the waiting list for less than 30-days were excluded from the

30-day survivorship analysis (n=188, 17.3%). Those on the waiting list for more than 30- but less than 90-days were excluded from the 90-day analysis (n=417, 46.3%). All patients were drawn from the same population. Therefore, many of the patients in the revision arthroplasty population were included in the waiting list population if they had been on the waiting list for 30-days or more. Following exclusion, 901 patients in the revision THA waiting list group were available for the 30-day survivorship analysis and 484 patients for the 90-day analysis. In the revision THA group, 561 patients were available for the 30- and 90-day survivorship analysis respectively.

Retrieval of information pertaining to death was completed as previously described [21]. Using the Demographics Batch Service through the NHS Connecting for Health, the details of the two populations were traced against the national Personal Demographics Service which stores information regarding demographic characteristics of all users of the NHS within the United Kingdom (UK). It was possible to identify patients who had died within each group as well as the date of death. In each group, patients who died within 90-days either after the operation or after being listed for the operation were identified. Death certificates for these patients were retrieved from the UK General Register Office, and the cause of death was identified.

In the population of patients undergoing revision THA, surgical technique was at the discretion of the operating surgeon and could include all-component revision, isolated component or liner revision or arthrotomy and prosthesis removal. The method of anaesthesia was at the discretion of the anaesthetist. Prophylactic antibiotics were administered as per hospital protocol. All patients were fitted with

graduated compression/anti-embolism stockings at the time of surgery and were advised to wear them for six weeks after surgery unless contraindicated. Any other chemical or mechanical thromboprophylaxis was prescribed according to the hospital policy at the time of the procedure.

Mortality rates were calculated on the basis of cut-off points of 30- and 90-days following the date of surgery or the date of listing for the reasons listed above. Confidence intervals were calculated with the score method [23]. A chi-squared test was used to compare the proportions of patients who died between the waiting list and the revision arthroplasty group. Data distribution was checked with a D'Agostino and Pearson normality test. Where data were not normally distributed, central tendency is described with the median and inter-quartile ranges (IQR). Where data were normally distributed, central tendency was described with the mean and standard deviation. Normally distributed data comparison was performed with parametric tests and non-normally distributed data with non-parametric tests (Mann–Whitney test). For illustrative purposes, patients in each group were stratified according to age and the mortality rate and day-by-day mortality were calculated. A multiple regression model was used to determine if age or gender influenced the risk of death in the waiting list or revision arthroplasty groups at 90-days

Results

In the 30-day revision THA comparison, the median age was 70 years (IQR 60-76) in those on the waiting list and 69 (IQR 60-77) for those undergoing revision THA ($p=0.999$). In the 90-day revision THA comparison, the median age was 70 (IQR 60-

76) in those on the waiting list and 69 (IQR 60-77) in those undergoing revision THA (p=0.741).

There were no significant differences in gender distribution in the 30-day comparison for revision THA (p=0.451, waiting list group 43.6% male, 56.4% female; revision THA group 45.6% male, 54.4% female) or the 90-day comparison for revision THA (p=0.745, waiting list group 44.6% male, 55.4% female; revision THA group 45.6% male, 54.4% female).

The 30-day mortality of patients on the waiting list for revision THA was zero (95% confidence interval 0.000% to 0.425%). The 30-day mortality following revision THA was 0.357% (95% confidence interval 0.098% to 1.290%). The odds ratio could not be calculated as the mortality of the waiting list group was zero. The excess surgical mortality at 30-days was significantly increased in the surgical group at 0.357% (95% confidence interval 0.098% to 0.866%; p=0.037).

The 90-day mortality of patients on the waiting list for revision THA was 0.207% (95% confidence interval 0.036% to 1.161%), and 1.070% (95% confidence interval 0.491% to 2.314%) following revision THA. The odds ratio was 5.22 (95% confidence interval 0.626 to 43.524). The excess surgical mortality at 90-days was 0.863% (95% confidence interval 0.455% to 1.153%; p=0.045).

The multiple regression model was only applied if there was more than one death in the group of interest. There was only one death in the THA waiting list group at 90-days. In this cohort of patients, using the multiple regression model previously used

in our primary arthroplasty cohorts [20, 21] neither age ($p=0.051$) nor gender ($p=0.89$) were shown to have a statistically significant association with the risk of death in the 90-day revision THA group. The survivorship of patients at 90-days following being placed on the waiting list for revision THA and those undergoing revision THA is shown in Figure 3. Death certificates were available for all of those patients who died within 90-days of the revision arthroplasty and the one patient who died within 90-days of being added to the revision THA waiting list. The cause of death as detailed on the death certificate in each population is shown in Table 1. When the operative groups were combined, the dominant cause of death postoperatively was a cardiovascular event.

Conclusions

The aim of this study was to assess the incidence of mortality following revision hip arthroplasty, and to compare this to the incidence of death in a population of patients on the waiting list for the same procedure. Using this previously described method [20, 21], we set out to establish if there was an excess surgical mortality rate for patients undergoing revision THA to inform our counselling of patients. In the current study, we have shown that there was an excess surgical mortality rate for patients undergoing revision THA at 30- and 90-days.

The National Joint Registry's 13th annual report for England and Wales has reported an increase in the number of primary THAs [4] being performed. This rise is in keeping with other published literature [5-7]. Importantly, recent data has shown a secular decline in the short-term mortality rate for primary arthroplasty with the 90-day mortality for primary THA decreasing from 0.56% in 2003 to 0.29% in 2011 [22].

With the revision burden (defined as the ratio of revision arthroplasties to the total number of primary procedures) remaining relatively constant [5,8,11], in spite of improvement in technologies and surgical technique [9], the increase in primary arthroplasty procedures will have a direct effect on the incidence of revision procedures. There is however, a paucity of published data on the short-term mortality rate of patients undergoing revision arthroplasty. Although not directly comparable, Lindberg-Larsen et al. [14] have shown a similar 90-day mortality rate of 1.4% for patients undergoing revision THA for aseptic failure only. When comparing our all cause revision to other published studies, we have a similar early mortality rate to Fehring et al. [13], who showed a 3-month mortality rate of 0.9%, but a lower rate than in a Medicare population (90-day mortality rate of 2.6%) [12]. These rates are crude mortality figures, whereas in this study we also present an excess surgical mortality rate of 0.863%, using the waiting list population for the same procedure as our control group.

The cause of death in this study in the revision arthroplasty group is in keeping with those described by others, with cardiovascular events being the main cause of perioperative mortality [20, 21, 24-26]. As with our previous studies [20, 21], fatal pulmonary embolus did not feature as a cause of death which is in contrast to some published studies [25,27-28], but concordant with findings from extremely large registry studies of mortality after primary arthroplasty [26], suggesting that fatal pulmonary embolus is a rare event following revision lower limb arthroplasty in our population. A recent study published in the Lancet has shown that mechanical and chemical thromboprophylaxis act independently and reduce mortality for patients undergoing primary THA [22]. Patients in this study did not receive a standardised

thromboprophylaxis regime but all received both mechanical and chemical thromboprophylaxis meaning conclusions cannot be made regarding the efficacy of any particularly prophylaxis regime.

There are several limitations in this study. Early death after joint arthroplasty is rare [12-13, 16, 17, 20-22, 29] and thus our sample size may be too small to detect differences. In addition to this, we lost a lot of patients available for the survivorship analysis on the waiting list at 90-days for revision THA when compared to the number of patients available in the 30-day analysis (Figure 2). The main reason for this is the eighteen-week National Health Service (NHS) target for electively admitted patients which was first introduced in 2004 [30] and requires a 90% compliance from referral to treatment. Secondly, as a retrospective study, we relied on data from our institutions registry as well as national registries to gain data for the patients who underwent procedures and those reported to have been deceased. This relies on accurate reporting and recording of patient data at the time of the event which could affect our results. Thirdly, unlike the papers looking at primary arthroplasty procedures, we were unable to tightly control for the type of procedure performed within the revision setting. The range of operations included under the definition of revision THA is broad including for example debridement and implant retention, single stage revision, first stage or second stage revision and excision arthroplasty. This represents a range of surgical trauma and operative time and due to the heterogeneity of procedures, our small sample size and that we censored patients following their first revision procedure, we are unable to draw conclusions on sub-types of revision surgery as to which has the greatest influence on mortality rates in this population or on the effect of the subsequent procedures.

Another potential bias within our results was the exclusion of patients in the waiting list group if they were removed within 30-days. Doing this may have removed most of the patients with infected THA and therefore could have created a “well patient” phenomenon in the waiting list group when compared to the revision group. We also did not assess the reason for revision and were therefore unable to subdivide the groups into septic and aseptic groups. Choi et al. [31] have shown that there is not a significant difference in mortality following revision THA at a median follow up of 5 and 6 years for septic versus aseptic failures respectively. The same study did show that the mean age of the time of death is significantly younger in those patients undergoing revision THA for septic rather than aseptic revision. Nonetheless, an analysis of mortality in septic versus aseptic revision may have provided more useful information within our study. Despite these limitations however, we have been able to highlight, as with our previous studies [20-21], the importance of finding an appropriate control group to compare the surgical mortality rate to.

In summary, with the control group as the waiting list population, we have demonstrated that revision THA is associated with a significant excess surgical mortality rate at 30- and 90-days post operation with a five-fold increase in the risk of mortality within 90-days of surgery. We would encourage other authors with access to larger samples to use our method to quantify excess mortality after both primary and revision arthroplasty procedures. As with previous studies, cardiac events were the main cause of postoperative deaths and further work is required to address this. The data provided in this study should aid surgeons and patients in making informed decisions regarding the risk of mortality following revision THA.

Acknowledgements

Conflict of Interest:

- Mark Jones: None
- Michael Parry: None
- Michael Whitehouse: Speakers bureau/paid presentations by DePuy and Heraeus (money paid into University administered research fund, research support as Principal Investigator by DePuy (research grant for consumables), travelling fellowship from Zimmer administered by the BOA and he is on the Hip International Editorial Board.
- Ashley Blom – Research support from Stryker as principal investigator.

Funding Sources: None

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Table 1

Cause of Death	No of Deaths	
	Post-Operative Revision	Waiting List Revision
	THA Cohort	THA Cohort
Bronchopneumonia	0	1 (100%)
Myocardial Infarction	2 (33.3%)	0
Sepsis	1 (16.6%)	0
Ischaemic Heart Disease	1 (16.6%)	0
Cerebrovascular event	1 (16.6%)	0
Non Hodgkins Lymphoma	1 (16.6%)	0
*The percentages are based on the total number of deaths in the group.		

Figure and Table Legends

Table 1. Cause of death as detailed on the death certificates of patients who died within ninety days after undergoing revision total hip arthroplasty (THA) or after being added to the waiting list for revision arthroplasty

Figure 1. Flowchart demonstrating the preparation of the revision arthroplasty groups.

Figure 2. Flowchart demonstrating the preparation of the waiting list groups.

Figure 3. Ninety-day mortality for patients undergoing revision total hip arthroplasty compared to those remaining on the waiting list for the same procedure

Figure 1

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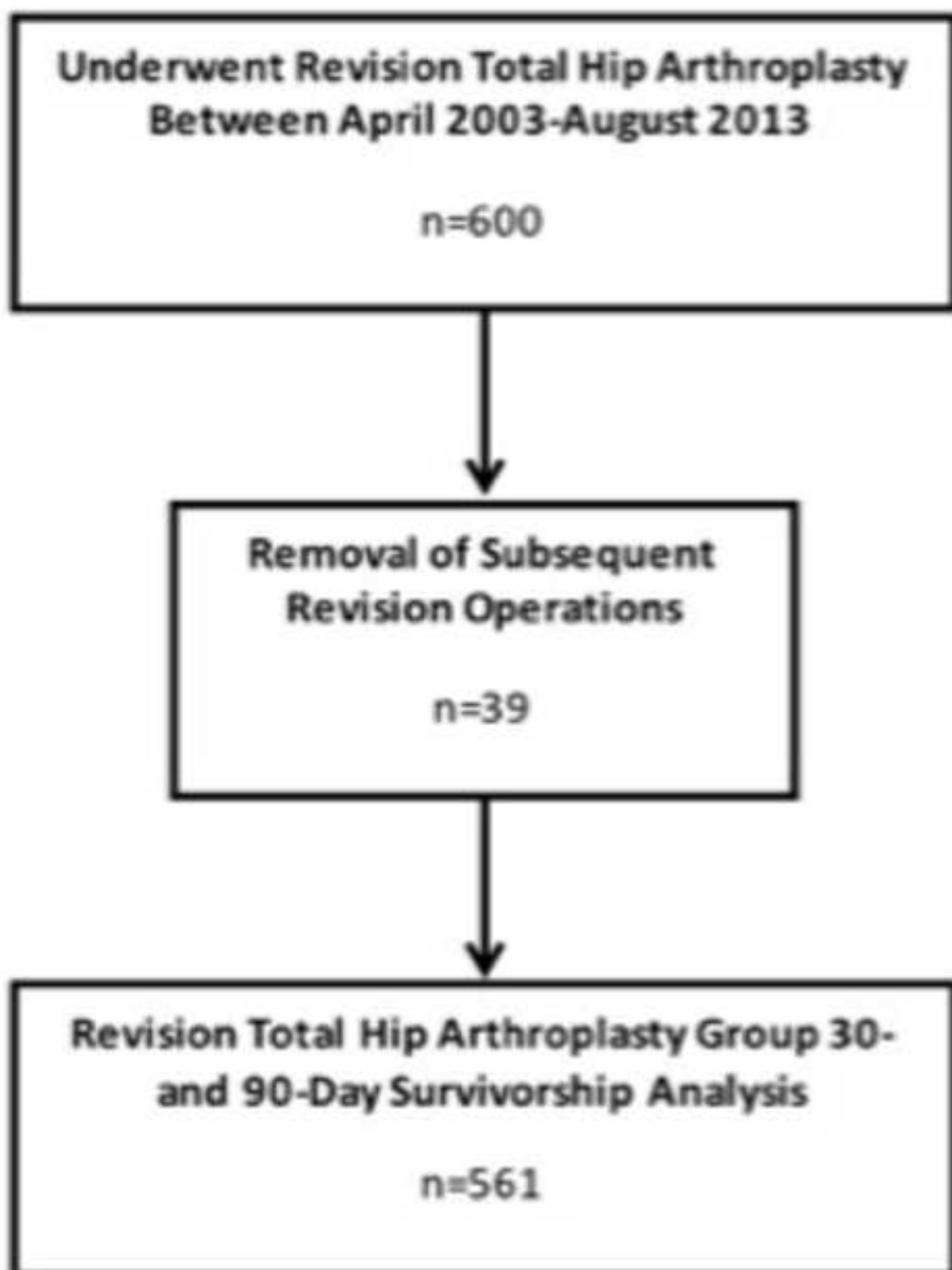


Figure 2

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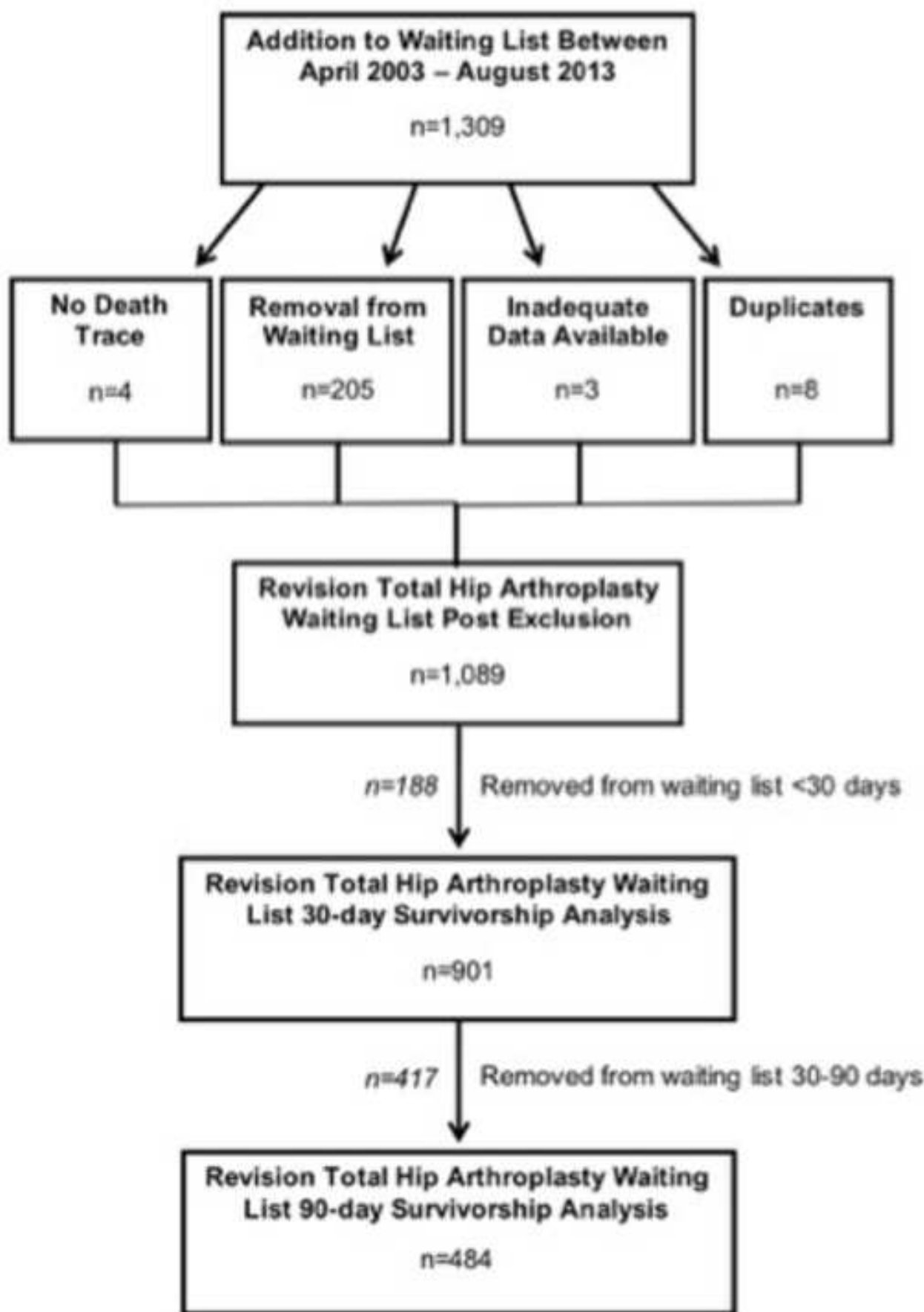


Figure 3

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